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Spectrophotometric determination of Malathion(an organo phosphorous insecticide) with Potassium bromate

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Abstract

Malathion is an organophosphate insecticide. A simple spectrophotometric method for the determination of malathion is described. Malathion is decomposed by alkali to dimethyl dithiophosphate. The formed dimethyl dithiophosphate reacts with potassium bromate in presence of dilute nitric acid with the formation of orange-yellow color.The absorbance maximum was observed at 415 nm.The Beers law is obeyed up to 8 ppm for malathion standard solution. Water and vegetable samples were collected in different areas of Visakhapatnam district, Andhra Pradesh,India to determine the malathion and found low levels in the range up to 0.04 ppm.Interference study was carried for other pesticides and ions.

Keywords:

Malathion, potassium bromate, spectrophotometry

1. Introduction

Malathion is an insecticide of relatively low human toxicity however recent studies have shown that children with higher levels of malathion in their urine seem to be at an increased risk of hyperactive disorder [1]. It is used in agriculture, residential landscaping, public recreation areas, and in public health pest control programs such as mosquito eradication [2]. In the US, it is the most commonly used organophosphate insecticide [3]. The chemical name of malathion is Diethyl 2-[(dimethoxyphosphorothioyl)sulfanyl] butanedioate with molecular formula $C_{10}H_{19}O_6PS_2$ and molecular weight is 330.3. Technical grade is 95% pure.

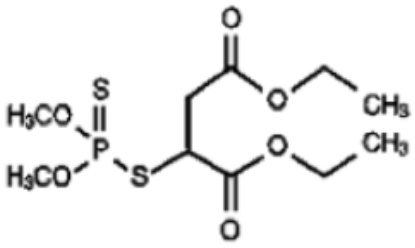

Fig. 1. Structure of malathion

Malathion itself is of low toxicity; however, absorption or ingestion into the human body readily results in its metabolism to malaoxon, which is substantially more toxic [4]. Acute exposure to extremely high levels of malathion will cause body-wide symptoms whose intensity will be dependent on the severity of exposure. Possible symptoms include skin and

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eye irritation, cramps, nausea, diarrhea, excessive sweating, seizures and even death. Most symptoms tend to resolve within several weeks. Malathion present in untreated water is converted to malaoxon during the chlorination phase of water treatment, so malathion should not be used in waters that may be used as a source for drinking water, or any upstream waters. If malathion is used in an indoor, or other poorly ventilated environment, it can seriously poison the occupants living or working in this environment. A possible concern is that malathion being used in an outdoor environment, could enter a house or other building; however, studies by the EPA have conservatively estimated that possible exposure by this route is well below the toxic dose of malathion. Regardless of this fact, in jurisdictions which spray malathion for pest control, it is often recommended to keep windows closed and air conditioners turned off while spraying is taking place, in an attempt to minimize entry of malathion into the closed environment of residential homes. Although current EPA regulations do not require amphibian testing, a 2008 study done by the University of Pittsburgh found that "cocktails of contaminants", which are frequently found in nature, were lethal to leopard frog tadpoles. They found that a combination of five widely used insecticides (carbaryl, chlorpyrifos, diazinon, endosulfan, and malathion) in concentrations far below the limits set by the EPA killed 99% of leopard frog tadpoles.[5].Malathion is analysed by Gas Liquid Chromatography & High Performance Liquid Chromatography. Now an attempt has been made to develop a new method for analysis of Malathion in biological samples using Thin Layer Chromatography (TLC) technique, which is inexpensive, accurate and non-destructive. Malathion was extracted from blood and urine using solvent extraction methods and then identified on the TLC plates.

Khuhawar [6] desribed a high-performance liquid chromatographic method has been developed for the quantitative determination of the organophosphorus pesticide malathion. The method is based on alkaline hydrolysis of malathion to dimthyldithiophosphate (DDTP) which is complexed with copper(II) and extracted in chlorofrom. The complex is injected onto a Hypersil ODS or Licrosorb sicolumn and eluted with acetonitrile:methanol:water (80 : 10 : 10 v:v:v) or chloroform. Detection is at 245 or 260 nm. A linear calibration curve was obtained for 24–240 ug mL^{-1} DDTP and a detection limit of 2.4–4.8 ng DDTP per injection. The method was applied to the analysis of malathion in commerical products after spraying on leaves. Extrction efficiency of malathion from leaves in acetone-water was also evlauted.

The first colorimetric method was devised by Norris. et.al [7] and applied for malathion residue analysis.Spectroscopic mehtod for the determination of malathion described in this paper involves alkaline hydrolysis and the reaction with potassium bromate which causes the final absorption measurement. The present investigation a simple reagent potassium bromate and acid reagent are used for for the spectrophotometric determination of malathion. The formed orange yellow colour is measured at 415nm. This decrease in absorbance is directly proportional to the malathion concentration. The proposed method has been successfully applied for the determination of malathion in water, and vegetables.The vegetable samples collected from various places near sabbavaram area, Visakhapatnam District, Andhra Pradesh, India.

2. Experimental

2.1. Insrumentation

A JASCO (Model UVIDEC-610 UV-VIS Spectrophotometry with 1cm matched quartz cuvettes was used for all absorbance measurements. Systonics pH meter (model 331) is used.

2.2. Reagents

A stock solution of malathion (1 mg mL^{-1}) was prepared in ethanol and working standard was prepared by appropriate dilution of the stock. A 0.1 N Potassium bromate and 2% alcoholic potassium hydroxide were used. All other chemicals used were Analytical reagent grade

2.3. Method

i) 1 mL of alcoholic potassium hydroxide was added to an aliquot of working standard of malathion (0.5-8.0 µg mL^{-1}). 10 mL of 0.1N potassium bromate was added. 0.5 mL of 1:1 nitric acid and 2 mL of double distilled water are added to give orange yellow color. The solution was kept aside for 5 min before taking absorbance and absorbance was measured at 415nm against reagent blank. The absorbance corresponding to the bleached color which in turn corresponds to the analyte malathion concentration was obtained by subtracting the absorbance of the blank solution from that of test solution.

ii) Water samples (5 mL), 5 g of finely ground vegetable samples (5 g) were spiked with known amount of the working standard solution of malathion. Aliquots of the washed extracts of endosulfan were evaporated off under suction. To the residue, 5 mL of acid reagent and 1 mL of alcoholic potassium hydroxide solutions were added. 5ml of potassium bromate solution was added and analyzed by the proposed method. Suitable volume of aliquot was analyzed according to the proposed and reference method. The results are tabulated in Tables 1 and 2.

Table 1. Determination of malathion in water and vegetables

Samples	Amount of Malathion(µg/mL)**	
	Proposed Method	Reference method[8]
Water	1.63 ± 0.01	1.61 ± 0.01
Cauliflower	5.12 ± 0.02	5.06 ± 0.02
Potato	6.1 ± 0.03	6.0 ± 0.05
Spinach	8.0 ± 0.05	8.23± 0.01

** mean ± standard deviation(n=5)

Table 2. Optical characteristics and precision data

λmax (nm)	415 nm
Color	Orange-yellow
Beer's law range	0.5-8 µg/mL
Detection limit	0.13 µg/mL

3. Results and Discussion

The method is based on the alcoholic alkaline hydrolysis with potassium hydroxide. The reaction with potassium hydroxide in presence of an acid reagent forms an orange yellow colorand measured at 415nm.The absorption maximum is shown in Fig. 2.

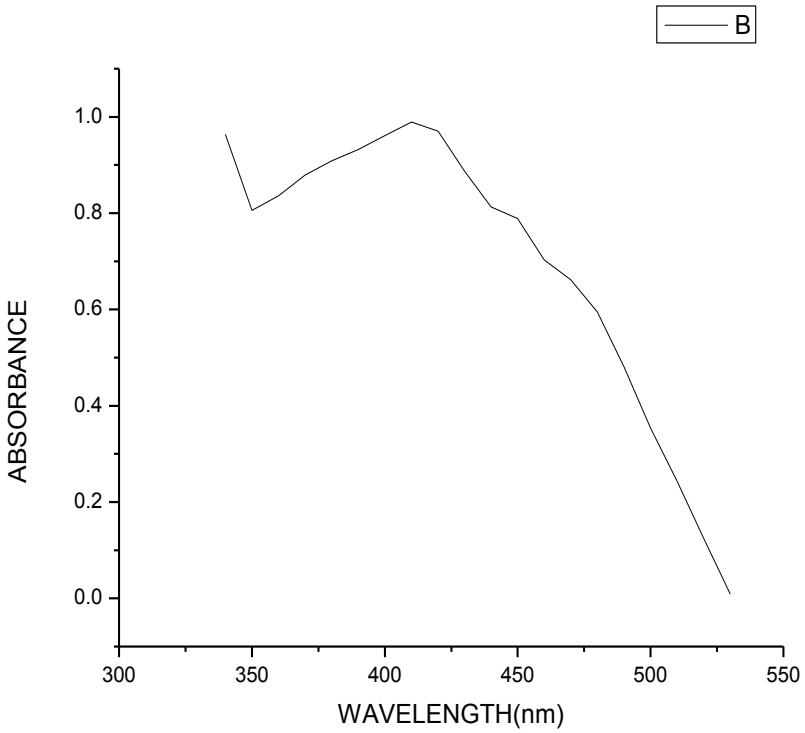

Fig 2. Absorption maximum of malathion

The decrease tendency in absorbance is proportional to malathion. The Beer's law is obeyed in the range of 0.5-8 μg mL^{-1} and it is shown in Fig. 3.

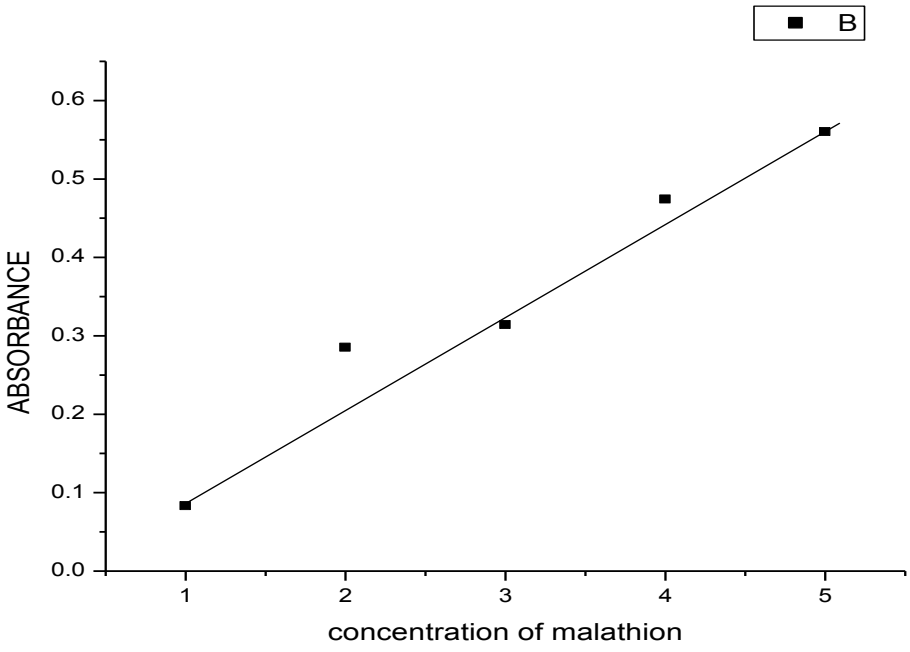

Fig 3. Absorbance versus concentration graph of malathion

The method has been applied for the determination of malathion in various water, and vegetable samples.The various samples were collected from sabbavaram areas in Visakhapatnam District, Andhra Pradesh, India. The various vegetables collected are cauliflower, potato, spinach, etc. The proposed method is simple, selective, sensitive and rapid, offers the advantage of high sensitivity and has wide analytical range of determinations without the need for extraction or heating.

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